



**2022 CWISummit  
Scientific Session - Saturday**

Moderator: Alicia Mangram, MD, FACS  
Recorder: Matthew B. Dull, MD, FACS

**Title:**

Biomechanical characteristics and anatomical positioning of rib fracture fixation systems

**Presenting author:**

Jonne T.H. Prins, MD

Erasmus MC, University Medical Center Rotterdam, The Netherlands, PhD Candidate

Imagine you can instantly learn any language. Which would you choose? Mandarin

**Discussant:**

Zachary D. Warriner, MD, FACS

University of Kentucky, Assistant Professor of Surgery

Name one item still on your bucket list. PADI rescue diver certification

**Authors:**

- Jonne T.H. Prins, MD
- Suzanne F.M. Van Wijck, MD
- Sander A. Leeflang, Ing
- Gert-Jan Kleinrensink, MD, PhD
- Lawrence Lottenberg, MD, FACS
- Pablo Moreno de la Santa Barajas, MD
- Pieter J. Van Huijstee, MD, PhD
- Jefrey Vermeulen, MD, PhD, MSc
- Michael H.J. Verhofstad, MD, PhD
- Amir A. Zadpoor, PhD
- Mathieu M.E. Wijffels, MD, PhD

**Background:** Concurrent to the increase in surgical stabilization of rib fractures (SSRF), there has been an increase in the number of available fixation systems. The aim of this anatomical and biomechanical study was to assess the positioning of these implants in relation to the intercostal groove. Secondary objectives were to determine the biomechanical properties of the implants fixated on a fractured and on an intact rib, and to compare these characteristics with that of a non-fixated intact rib.

**Methods:** The bilateral 6th to 10th rib of five embalmed post mortem human specimens were fixated with five fixation systems (n=25 fractured ribs; n=25 intact ribs) while the 5th rib (n=10 intact ribs) was used to define the biomechanical characteristics of a non-fixated intact rib. After fixation, bilateral intercostal nerves of the 6th to 10th rib were dissected to visualize and evaluate contact of the implant with the nerve. Then, the shortest distance of the implant (i.e., plate, screw, or clip) to the intercostal groove was measured for every construct. Each rib was subjected to a four-point bending failure test in order to determine the structural bending stiffness (EI; Nm<sup>2</sup>), load to failure (F<sub>max</sub>; N), failure mode, and the average relative difference in EI and F<sub>max</sub> in relation to an intact 5th rib.

**Results:** The shortest mean distance from the implant to the intercostal groove ranged from 1.2 mm (standard deviation [SD] 0.74) for the Niti Rib system to 6.6 mm (SD 1.66) for the RibFixBlu™ system. As compared to a non-fixated intact rib, the average relative difference in EI of a fixated





**2022 CWISummit  
Scientific Session - Saturday**

Moderator: Alicia Mangram, MD, FACS  
Recorder: Matthew B. Dull, MD, FACS

**Title:**

Impact of Concurrent Spine Fractures on the Performance of and Outcomes After Surgical Stabilization of Rib Fractures

**Presenting author:**

Thomas J. Martin

Brown University, Medical Student

What is a current trend that you just don't understand? TikTok - all of it

**Discussant:**

David H. Livingston, MD, FACS

**Authors:**

- Anastasia Tillman, BA
- Stephanie Lueckel, MD, ScM
- Tareq Kheirbek, MD, ScM, FACS

**Background:** Surgical stabilization of rib fractures (SSRF) has been shown to improve outcomes in patients with chest wall injury. However, the impact of concurrent spinal fractures on patient outcomes and surgeon decision to perform of SSRF remains uncharacterized. We hypothesized that SSRF reduces mortality among patients with concurrent spinal fractures, but that time-to-surgery may be delayed by the presence of potentially unstable spine injuries.

**Methods:** We performed a retrospective analysis of the Trauma Quality Improvement Program 2019 dataset to identify adult patients with rib fractures and Abbreviated Injury Scale (AIS) Chest > 2, excluding those with 24-hour mortality or any AIS body region of six. We used ICD-10-CM codes to identify patients with concurrent spinal fractures (SFx), excluding fractures of the transverse or spinous processes. We compared baseline patient characteristics, rates of in-hospital morbidity and mortality, and the incidence and timing of SSRF between groups. Multiple logistic regression was controlled for age, sex, injury severity (ISS), comorbidities, and in-hospital complications based on bivariate analyses. We also performed prespecified subgroup analyses of patients with concurrent SFx stratified by SSRF.

**Results:** We included 101,409 patients with rib fractures, of which 15,208 (15.0%) had concurrent SFx and 2,980 (19.6%) of those required spine surgery. SFx patients were relatively younger, had less medical comorbidities, and were more severely injured (ISS>16: 69.7 vs 39.1%, p<0.0001) with higher rates of pelvic fractures (16.3 vs 10%, p<0.0001). SFx patients had significantly higher rates of all complications (ARDS, VAP, DVT/PE, Stroke) and had higher in-hospital mortality (7.8 vs 3.7%, p<0.0001) compared with rib fractures alone. Bivariate analyses also demonstrated a higher rate of SSRF (3.2 vs 2.9%, p=0.04) yet prolonged time-to-surgery (5 [3, 7] vs 4 [3, 6] days, p<0.0001) for patients with SFx, with 32.3 vs 43.4% (p<0.0001) undergoing early SSRF within 72h of admission. The presence of concurrent SFx was associated with higher adjusted odds of mortality (OR: 1.57 [1.37, 1.79]), however, was not independently associated with receiving SSRF. In the subgroup analysis of





**2022 CWISummit  
Scientific Session - Saturday**

Moderator: Alicia Mangram, MD, FACS  
Recorder: Matthew B. Dull, MD, FACS

**Title:**

Surgical Stabilization of Rib Fractures in Patients with Competing Operative Pelvic Injuries: Earlier Repair of Rib Fractures is Feasible

**Presenting author:**

Husayn Ladhani, MD  
Denver Health, Fellow

**Discussant:**

David Ciesla, MD, FACS  
UC Health – Loveland, Colorado

**Authors:**

- Husayn A. Ladhani, MD
- Clay Cothren Burlew, MD, FACS
- Suzanne F.M. van Wijck, MD
- Elizabeth F. Smith, MSPH
- Julia R. Coleman, MD, MPH
- Chelsea Horwood, MD, MPH
- Nicole L. Werner, MD, MS, FACS
- Ryan Lawless, MD
- Barry Platnick, MD
- Ernest E. Moore, MD, FACS
- Daniel VanDerPloeg, MD

**Background:** Early surgical stabilization of rib fractures (SSRF) is associated with improved pulmonary outcomes, but the timing of SSRF in patients with competing operative injuries and its impact on outcomes is unknown. The purpose of this study was to evaluate the timing and outcomes of SSRF between patients with and without an operative pelvic fracture. We hypothesized that SSRF can be performed early in patients with an operative pelvic fracture without a difference in outcomes.

**Methods:** We reviewed all SSRF patients from 2010-2020 via a prospectively maintained database. All patients were screened to identify patients who underwent SSRF as the only operative intervention (SSRF group) and patients who underwent SSRF and operative management of pelvic fractures (SSRF+P group). Demographics, injury characteristics, operative details, and outcomes were obtained and compared between the two groups. Continuous variables were compared using the Mann-Whitney U test, and categorical variables were compared using the Chi-square test.

**Results:** During the 11-year period, 154 patients were identified with median age of 54 years; 70% were male and median ISS was 17. Of these, 143 patients were in the SSRF group (93%) and 11 patients were in the SSRF+P group (7%). There was no difference in median age, gender, and pulmonary comorbidities between the two groups. Median ISS was higher in SSRF+P group (26 vs 17,  $p < 0.001$ ) without a difference in injuries to head, neck, clavicle, scapula, spine, long bones, and solid organs between the two groups. Median number of rib fractures (9 vs 7,  $p = 0.036$ ), total number of fractures (15 vs 11,  $p = 0.001$ ), flail segment (91% vs 54%,  $p = 0.024$ ), and hemothorax (91% vs 57%,  $p = 0.028$ ) were higher in SSRF+P group, without difference in median Blunt Pulmonary Contusion 18





**2022 CWISummit  
Scientific Session - Saturday**

Moderator: Alicia Mangram, MD, FACS  
Recorder: Matthew B. Dull, MD, FACS

**Title:**

The Evolution of a Rib Clinic During a Pandemic

**Presenting author:**

Amanda Waite, MSN, ACNP  
MUSC, Trauma Nurse Practitioner

What is a current trend that you just don't understand? Jean that are all holes and held on by a small thread

**Discussant:**

Michael S. Truitt, MD, FACS  
Methodist Dallas, VP/DIO GME, PD General Surgery  
Name one item still on your bucket list. Dive the Great Barrier Reef

**Authors:**

- Shaune Shivers
- Evert A. Eriksson, MD, FACS, FCCM, FCCP

**Background:** In the fall of 2019, we sought to develop a rib clinic to treat patients with chest wall pain and rib fractures. This initiative was fueled by the recognition of an unmet need as well as evolving research demonstrating improved patient care and experience. We will describe the evolution of this clinic program from an Acute Care Surgery / General Surgery (ACS/GS) clinic to a Rib Clinic (Rib).

**Methods:** We identified patient outpatient encounters generated from a general surgery clinic staffed by a physician and nurse practitioner team. A retrospective review was performed to identify outpatient encounters and surgeries associated with these encounters from 1/1/2017 – 11/30/2021. Outpatient wRVU generation and operative wRVU production was compared. Payer mix between rib patients and ACS/GS was compared.

**Results:** Over this time period, the number of clinic interactions decreased from 284 visits in 2017 to 229 visits in 2021. Clinic productivity increased however from 181 wRVU in 2017 to 295 wRVU in 2021. The distribution Rib patient visits increased from 4% to 70%. Additionally, telehealth visits have increased from 0% to 23% of encounters. The operative wRVU productivity attributable to outpatient clinic visits increased from 253 in 2017 to 591 in 2021. Combined, the outpatient clinic and elective cases resulted in an overall growth of 104% in total wRVU productivity. The payer mixes for patients with rib diagnosis have a higher number of Blue Cross Blue Shield, Medicare, Managed Care, and Workers Compensation insurance compared to ACS/GS which had a higher number of Medicaid, HMO, and Self-Pay. The most common diagnosis was rib fracture initial evaluation (37%), rib fracture subsequent encounter (25%), rib pain (24%), and flail chest initial evaluation (4%).

**Conclusion:** The initiation of a rib clinic increased wRVU production despite a decrease in clinical encounters. These clinics may produce more wRVU per encounter than ACS/GS clinics. An







**2022 CWISummit  
Scientific Session - Saturday**

Moderator: Alicia Mangram, MD, FACS  
Recorder: Matthew B. Dull, MD, FACS

**Title:**

The Forequarter Lateral Implosion Injury and the Ch-Sh (CH $\grave{a}$ -SH $\grave{a}$ ) Classification System

**Presenting author:**

Thomas Zachary Paull, MD

University of Minnesota, Research Fellow

If you were a baseball player, what would be your walk-up introduction song? Boom by P.O.D.

**Discussant:**

Laszlo Marco Hoesel, MD

St. Joseph Mercy Hospital Ann Arbor, MI, Acute Care Surgeon

**Authors:**

- Albert George, MD
- Thomas Paull, MD
- Josh Levine, BS
- Peter A. Cole, MD, FAAOA

**Background:** A laterally directed blow to the shoulder commonly results in multiple rib fractures and a shoulder girdle injury. We have characterized this constellation of injuries as the forequarter lateral implosion injury which we define as a patient with two or more rib fractures combined with an ipsilateral shoulder girdle injury [scapula, clavicle, or proximal humerus fracture, or an AC joint and/or SC joint dislocation]. The purpose of this study is to describe the morbidity and mortality, demographics, injury patterns, and associated injuries in patients with a forequarter lateral implosion injury. The Ch-Sh (CH $\grave{a}$ -SH $\grave{a}$ ) classification system was created to aid in the interpretation and understanding of this important pathology.

**Methods:** 133 patients from Jan 2019 to Dec 2020 were evaluated at our academic level 1 trauma center. Inclusion criteria were two or more rib fractures (ICD codes: S22.4 and S22.5) in combination with an ipsilateral scapula fracture (S42.1), proximal humerus fracture (S42.2), clavicle fracture (S42.0), AC joint dislocation (S43.1), SC joint dislocation (S43.2), and/or sternum fracture (S22.2). The electronic medical record and our institutional trauma registry database were reviewed to record demographics, injury characteristics, associated injuries, and outcomes.

**Results:** The mean age of the study population was 58 years old (SD=17) and 77% of patients were male. Table 1 highlights the distribution of chest wall and shoulder injuries. The mean number of fractured ribs was 6 (SD=2.7). 26% of patients sustained a flail chest. 60% had a clavicle fracture. 50% had a scapula fracture.

The mean ISS for this cohort was 22, ICU admission rate 37% and the 30-day mortality rate was 10%. Common associated injuries included head injury 57%, spinal fracture 53%, and other orthopaedic fractures 35%. Shoulder girdle surgery was performed for 33% of patients and rib fixation was performed on 19% of patients. 13% of patients underwent stabilization of both shoulder girdle and rib fractures.

